REMARKS

Upon entry of the present amendments, Claims 13-14 and 17-19 remain pending in the present application. Claims 13, 14 and 17 are amended herewith and Claims 1-12, 15 and 16 are canceled herewith.

Entry of Amendments Requested

The amendments merely rewrite, in independent form, Claims 13, 14, 17 and 18. In particular, each of Claims 13 and 14 have been rewritten to incorporate base Claim 1, as well as intervening Claims 6, 10, 11 and 12. Claim 17 has been rewritten to incorporate base Claim 1 as well as intervening Claims 6, 10, 15 and 16. Claim 18 has been rewritten to incorporate base Claim 1 as well as intervening Claims 6 and 10. Claims 1-12, 15 and 16 have been cancelled, leaving only Claims 13, 14 and 17-19 pending.

Because the claims merely rewrite in independent form claims that have been previously pending, Applicants respectfully submit that the amendments present no new issues. Furthermore, the arguments presented hereinbelow for the patentability of such claims have been previously presented in arguments asserting the criticality of limitations relating to the material selection, as further detailed below.

Accordingly, Applicants respectfully request entry of the amendments presented herein and consideration of the remarks below.

Rejections Under 35 U.S.C. § 103

In the final Office Action mailed March 4, 2004, the Examiner has continued to reject each of the examined Claims 1 and 6-19 under 35 U.S.C. § 103(a) as being unpatentable over Gates et al. (U.S. Patent No. 6,203,613) and Ritala et al., *Perfect Conformal TiN and Al_2O_3 Films Deposited By Atomic Layer Deposition.*

Claims 1-12, 15 and 16 have been canceled. Accordingly, the rejections with respect to these claims are moot. However, Applicants do not acquiesce in the rejections and expressly reserve the right to pursue claims of a similar scope in subsequent continuing applications or, in the event of a refusal to enter these amendments, on appeal in the present case.

With respect to remaining Claims 13, 14 and 17-19, Applicants respectfully submit that the application does indeed teach the criticality of the claimed compositions and unexpected

results arising therefrom. The Examiner has provided no teachings with respect to these claim limitations in the prior art, and relies instead on the very broad teachings of Gates to include "<u>any</u> combination of multilayer metal oxide film to form an insulation layer." In view of the criticality of these features, set forth below, and in view of the failure of the art of record to specify any material composition meeting these limitations, Applicants submit that the prior art fails to provide a *prima facie* case of obviousness.

<u>Criticality</u>

Applicants have clearly set forth the criticality of the material limitations recited in the claims remaining after entry of the present amendment. The teachings in the specification related to such criticality include, without limitation, the following sections:

> Moreover, the inventors have realized that ALD also avoids greater compositional flexibility. This realization has been applied to another source of stress and/or voids in semiconductor processing. In the course of fabricating an integrated circuit, the substrate is subject to multiple thermal cycles, in which various materials undergo different thermal expansions. Disparate materials can thereby withdraw from one another (causing voids) or compress one another (causing stress). This is particularly true of trenches formed in a structural layer and filled with a different filler material. For example, in a conventional shallow trench isolation context, silicon oxide has a different coefficient of thermal expansion (CTE) than the silicon substrate that surrounds it. In part because of the excellent control enabled by ALD, materials can be selected to minimize differential thermal expansion while achieving the traditional goals of device isolation.

Application as filed, p. 7, ll. 20-31.

> Figure 10 shows the silica-mullite phase diagram from W.E. Lee and W.M. Rainforth, <u>Ceramic Microstructures</u>, Chapam and Hall, p. 297 (1994). At temperatures less than about 1600°C, the equilibrium result of a mixture containing less than about 70 weight percent alumina with silica is a two-phase mixture of silica (SiO_2) and mullite ($3Al_2O_3$*$2SiO_2$). Silica and mullite are continuously miscible in this composition range. To a first approximation, their coefficient of thermal expansion (CTE) scales linearly. If a dielectric mixture with a CTE close to the CTE of silicon is used to fill the silicon trench, it is able to withstand large changes in temperature without stress at the dielectric/silicon interface.
>
> Line 300 in Figure 11 shows the coefficient of thermal expansion as a function of weight percent of Al_2O_3 in a mixture with SiO_2. The CTE silicon is shown by the horizontal line 310 at 2.3×10^{-6} /K. The slope of the mixture line

> 300 is not very steep near its intersection 320 with silicon line 310. At the intersection 320, a composition of about 30 wt % (weight percent) Al_2O_3 and about 70 wt % SiO_2, which is a two-phase mixture of about 40 wt % mullite and about 50 wt % silica at equilibrium, has the same coefficient of thermal expansion (CTE) as silicon, i.e., 2.5×10^{-6} /K.
>
> Preferably the mixture composition is such that the CTE falls within about plus or minus 20% of the CTE of silicon, *i.e.*, in the range from about 2.0×10^{-6} /K at point 330 to about 3.0×10^{-6} /K at point 340. This corresponds to an Al_2O_3 concentration between about 23 wt % and about 37 wt % in the mixture, and, after a phase transformation to thermal equilibrium, the two-phase mixture ranges from about 24 wt % mullite/75 wt % silica to about 50 wt % mullite/50 wt % silica. More preferably, the mixture's CTE falls within about plus or minus 10% of the CTE of the surrounding material, or between about 2.25×10^{-6} /K and 2.75×10^{-6} /K. This corresponds to an Al_2O_3 concentration in the mixture between about 26 wt % and about 34 wt %, and, after a phase transformation to thermal equilibrium, the two-phase mixture ranges from about 35 wt % mullite/65 wt % silica to about 40 wt % mullite/60 wt % silica.
>
> Preferably, to achieve a CTE within about 20% of silicon's CTE, ALD can be conducted with a ratio of silica cycles to alumina cycles of between about 20:1 and 1:10. More preferably, a CTE within about 10% of silicon's CTE can be achieved with a ratio of silica ("primary") cycles to alumina ("secondary") cycles of between about 10:1 and 3:1.

Application as filed at p. 18, l. 27 to p. 19, l. 27.

The above-quoted sections clearly provide support for the criticality of the ranges claimed in Claims 13, 14, 17, and 18. In particular, these sections provide support for a connection between the recited ranges of material limitations and advantages gained in better matching of the CTE between the shallow trench isolation filler insulation material and the surrounding silicon. Note that, because advantages are gained, relative to the art of record, over the entire claimed range, Applicants respectfully submit that criticality for the entire range is shown.

In view of the criticality of the recited material limitations, Applicants respectfully submit that the remaining claims are nonobvious and in condition for allowance.

CONCLUSIONS

In view of the foregoing amendments and remarks, Applicants respectfully request entry of the amendments and passage of the application to allowance. If, however, some issue remains that the Examiner feels can be addressed by Examiner amendment, the Examiner is cordially invited to call the undersigned for authorization.

Respectfully submitted,

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Dated: June 2, 2004

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